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DELAWARE NATIONAL ESTUARINE RESEARCH RESERVE

Stewardship Plan

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1.0 INTRODUCTION

1.1 Project Background

The Delaware National Estuarine Research Reserve (DNERR) is one of 29 National Estuarine Research Reserve System (NERRS) sites in the United States. The NERRS was established by the Coastal Zone Management Act of 1972, as amended, as each reserve involves a partnership between the National Oceanic and Atmospheric Administration (NOAA) and the Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Energy, Coastal, and Climate – Coastal Programs Section. The DNERR consists of two Reserve components, the Blackbird Creek Reserve (Townsend, DE) and the St. Jones Reserve (Dover, DE), which are located about 30 miles apart (Figure 1). These two reserve components include both brackish and freshwater estuaries and are representative of the diverse array of estuarine ecosystems found throughout the Mid-Atlantic States (DNERR, 2013).

This plan is a revision to the original *Blackbird Creek Reserve Ecological Restoration Master Plan* created in 2007 and will now be referred to as the *DNERR Stewardship Plan*. The DNERR Stewardship Plan is for the DNERR-owned parcels of the Blackbird Creek Reserve encompassing approximately 483 acres in southern New Castle County, Delaware. This plan is intended to guide ecological restoration initiatives for the DNERR-owned parcels of the Blackbird Creek Reserve.

For this document, DNERR-owned properties of the Blackbird Creek include all land acquired from 1990 - 2018. All DNERR-owned wetlands and forested uplands on acquired parcels will be managed to preserve environmental quality, minimize detrimental impacts and control invasive species (DNERR, 2013). This stewardship plan relates to the components of the NERRS mission to provide long-term research, education and interpretation, and the part of the DNERR's mission which includes preserving and managing natural resources within the Reserve.

In the *Blackbird Creek Reserve Ecological Restoration Master Plan*, acquired lands were referenced by the names of four tract areas: Lowes Tract, Manwaring Tract, Cornelius Tract and the Union Church-Taylor's Bridge Tract. Due to the undefined, large area of the named tracts and recent land acquisitions, restoration activities will be referenced by a Management Area number (Figure 2 & 3). The Management Areas of the Blackbird Creek Reserve were created within the original tracts of land using natural barriers as guidelines to ensure easy navigation for current and future conservation staff and researchers. Due to the use of natural barriers, there is not a consistent acreage for the 20 Management Area within the Blackbird Creek Reserve. The size of the management areas ranges from 2-96 acres, with some of the larger sections still being used for agricultural farming.

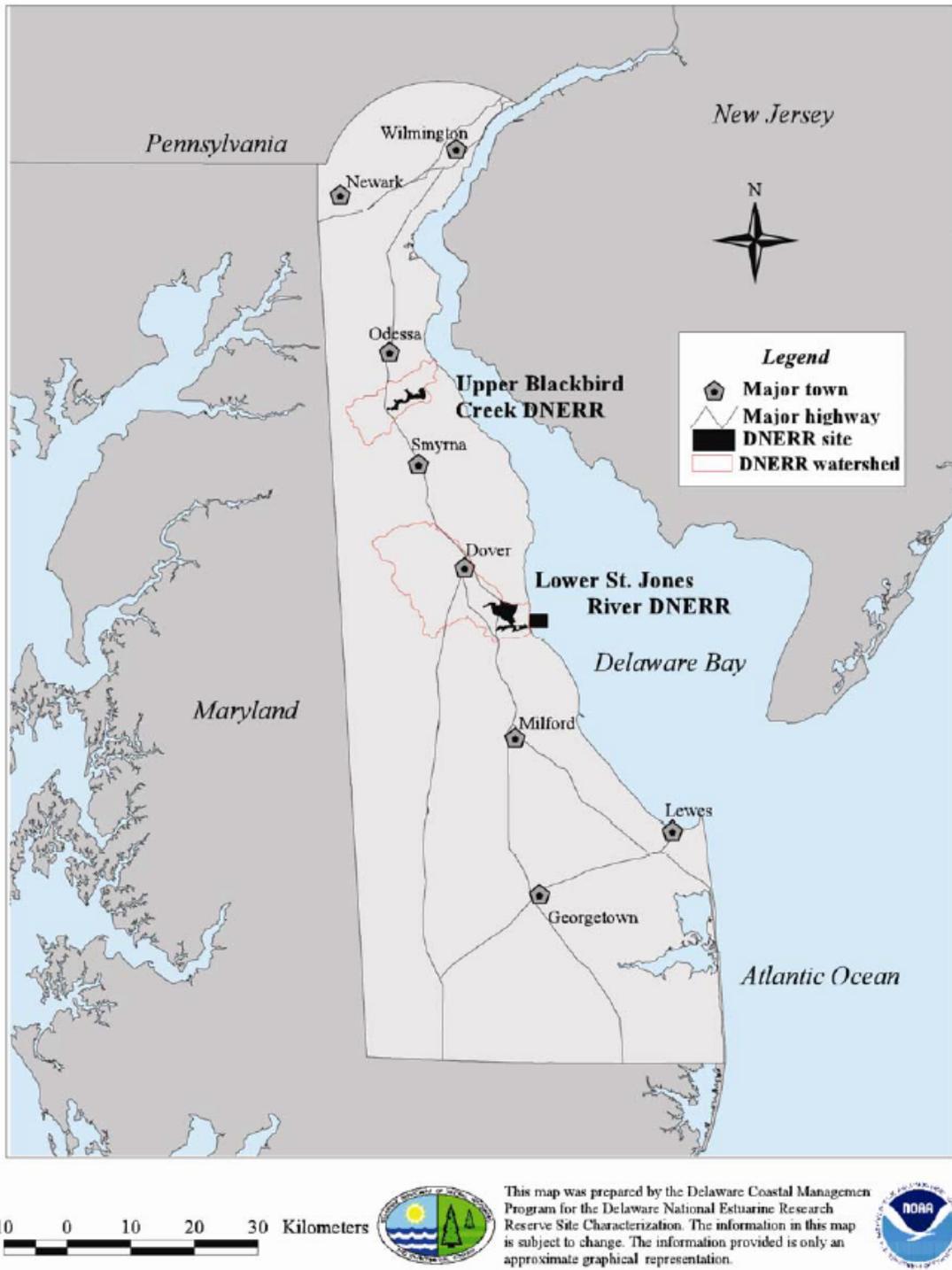


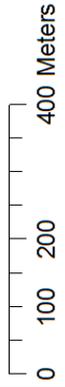
Figure 1. The two components of the Delaware National Estuarine Research Reserve



DNER Stewardship Plan
Blackbird Creek Reserve

Ecological Restoration Management Areas Figure 2

 Management Areas





DNERR Stewardship Plan
Blackbird Creek Reserve

Ecological Restoration Management Areas Figure 3

 Management Areas



1.2 Blackbird Creek

The Blackbird Creek Reserve component is 1,087 acres in designated size, situated along 5.7 miles of low-salinity brackish and freshwater tidal creek, starting about 5.8 miles upstream from where Blackbird Creek empties into the Delaware Bay. Within the Blackbird Creek designated boundaries, about 212 acres of tidal marshes, upland field, woodlots, and croplands were purchased by the DNERR in 1990. An additional 183 acres of tidal marsh, woodlands, and croplands were purchased in 1996 by DNREC's Division of Fish and Wildlife (as part of the Division's Cedar Swamp Wildlife Area), and is available for use in DNERR activities. In 2003, an 8 acre parcel was added to the Reserve to improve public access to the Blackbird Creek. In 2004, 62 acres was added at 801 Blackbird Landing Road, and in February 2005, 85 acres were added at 803 Blackbird Landing Road. Two additional properties, totaling 64 acres, were acquired in late 2005 and 2011 (DNERR, 2013). Two properties, a large area of mix native hardwoods and Delmarva Bays/Coastal Plain Ponds and wooded tributary buffers totaling 99 acres, was added to the Blackbird Creek Reserve in 2015. In 2016 & 2017, an additional 58 acres from 2 properties were added to 803 Blackbird Landing Road to improve wildlife corridor habitats. These new properties will be incorporated into the Reserves boundaries.

1.3 About This Plan

The need for an updated stewardship plan for the DNERR managed properties is clear. It has been 11 years since the original ecological master restoration plan was implemented and there has not been an evaluation of the successes or limitations encountered. Additional properties have also been added to the Blackbird Creek Reserve and there is a need to include these properties in future restoration efforts. The goal is to complete the Phases that were outlined in the *Blackbird Creek Reserve Ecological Restoration Master Plan* created in 2007 before pursuing additional restoration. This stewardship plan will guide the Blackbird Creek Reserve's restoration short term and long term efforts for the next 5-10 years. Site assessments conditions were not updated for the DNERR Stewardship Plan or newly acquired properties, but site assessments for properties purchased from 1990-2005 can be found in the *2007 Blackbird Creek Reserve Ecological Restoration Master Plan*.

Currently, there is not a separate stewardship plan for the St. Jones Reserve component on the DNERR. Instead, Stewardship Objectives and Actions for the St. Jones Reserve can be found in the most recent edition of the DNERR Management Plan. The 2023 revision of the DNERR Stewardship Plan will include a stewardship plan for the St. Jones Reserve and Blackbird Creek Reserve.

2.0 ECOLOGICAL RESTORATION AT THE BLACKBIRD CREEK RESERVE

2.1 Obstacles and Accomplishments

Currently, the DNERR is implementing Riparian Corridor Buffer Restoration, Upland Native Meadow Restoration, Upland Reforestation and Invasive Species Management. In the original *Blackbird Creek Reserve Ecological Restoration Master Plan*, restoration was recommended to be completed within 3 Phases over 15 years (Table 1). This timeline seemed reasonable within a written document, but obstacles (land acquisition, funding, program priorities, staff turnover, NEPA reviews, etc.) were not taken into account within the 15 year time frame. Unfortunately, restoration at the Blackbird Creek has been not been fully implemented within the recommended phases described in the *Blackbird Creek Reserve Ecological Restoration Master Plan*, but it is important to acknowledge restoration that has been completed over the past 11 years.

Table 1. Ecological Restoration Implementation phasing and actions 2007-2018**

Restoration Phase and Type	Restoration Target	Complete	Partially Complete	Incomplete
PHASE 1 (Year 1 - 2007-2008)				
Headwater Stream Restoration	1635 Linear Feet		●	
Riparian Corridor Buffer Restoration	725 Linear Feet (2.8 acres)		●	
Invasive Species Management	18 acres of upland, riparian & wetland		●*	
Wetland Restoration - Freshwater Nontidal	1 acre (including 2 'coastal plan ponds')	●		
PHASE 2 (Years 2-5 - 2008-2013)				
Headwater Stream Restoration	4280 Linear Feet			●
Riparian Corridor Buffer Restoration	1900 Linear Feet (34 acres)		●	
Invasive Species Management	15-20 acres annually		●*	
Wetland Restoration - Freshwater Nontidal	2 Acres (including 6-8 'coastal plain ponds')			●
Wetland Restoration - Tidal Marsh	13 ac fresh to oligohaline, 5 ac of brackish, and 6 acres of open water to tidal marsh			●
Upland Reforestation	3 acres		●	
Upland Native Meadow Restoration	23 acres		●	
PHASE 3 (Years 6-15 - 2013-2023)				
Invasive Species Management	15-20 acres annually		●*	
Wetland Restoration - Freshwater Nontidal	2 Acres (including 6-8 'coastal plain ponds')			●
Wetland Restoration - Tidal Marsh	27 acres fresh to oligohaline and 45 acres of brackish			●
Upland Reforestation	5 acres			●
Upland Native Meadow Restoration	13 acres			●

* *Phragmites control in wetlands not implemented; All other priority invasive species controlled*

** Actions based on Phase 1, 2, & 3 plan and does not include activities changed or completed outside of the original plan

Reforestation within recommended Upland and Riparian Buffer restoration areas was a learning experience for the DNERR. Bare root seedlings did not have a high success rate (wildlife & weather) and tree tubes remained on smaller trees longer than intended. After several years of care, such as invasive removal, mowing and replanting, some reforestation areas have been considered successful. The process of growing bare root seedlings in the DNERR Native Plant Greenhouse at the St. Jones Reserve has helped to increase the success of trees planted at the Blackbird Creek Reserve. Without the additional care, an area would have to be continually replanted and reforestation would not be complete.

In 2012, steps were taken with partners in DNREC and the University of Delaware to complete a section of the Phase 1 headwater stream restoration. Due to limited resources and technical concerns only 150 ft. of the headwater stream restoration was completed and still remains as an incomplete objective of the 3 Phases. A total of 3 coastal plain ponds have been restored, instead of the 8 targeted coastal plain ponds, but these ponds have been a favorite among local birders.

Invasive species removal and control is a priority and ongoing activity for the DNERR. All priority invasive species have been controlled to recommended requirements of the *Blackbird Creek Reserve Ecological Restoration Master Plan*. As additional properties were acquired at the Blackbird Creek Reserve, invasive species control and removal became the overall priority for the DNERR. Aquatic invasive species management within coastal plain ponds began in 2012. Unfortunately, *Phragmites australis* control within wetlands has not been implemented. For these reasons, Table 1 indicates that invasive species management has been partially completed since 2007.

2.2 Accomplishments: Beyond 2007 Restoration Phases

There are multiple restoration efforts that have been completed outside of the three phases detailed in the *Blackbird Creek Reserve Ecological Restoration Master Plan* (2007). These efforts include a project with Delaware State University, DNREC's Wetlands Assessment Program installing a living shoreline, property acquisitions and vegetation monitoring. Table 2 outlines all restoration projects that have been completed at the Blackbird Creek Reserve, but were not included in the *Blackbird Creek Reserve Ecological Restoration Master Plan*. The table also indicates if the area restored during the project differed from the designated restoration type in the *Blackbird Creek Reserve Ecological Restoration Master Plan*.

Two restoration efforts at the DNERR were completed outside of the recommendations from the *Blackbird Creek Reserve Ecological Restoration Master Plan*, but were successful at enhancing habitats within the Blackbird Creek Reserve. Delaware State University (DSU) implemented a project titled "Studies of Reforestation and Soil Conservation on Devastated Delaware Farmland," within Management Area 18 (Figure 2). The objective to develop effective, natural-accommodated reforestation and soil conservation techniques and used the Blackbird Creek Reserve as the experimental site for reforestation techniques. The second reforestation effort was

creating an Education Tree Plot in Management Area 2 of the Blackbird Creek Reserve. The goal of the Education Tree Plot was to provide an area with trees native to Delaware that were labeled for educational tree identification. Tree species planted included: sweet gum (*Liquidambar styraciflua*), dogwood (*Cornus florida*), Eastern red cedar (*Juniperus virginiana*), sycamore (*Platanus occidentalis*), Red maple (*Acer rubrum*) river birch (*Betula nigra*), loblolly pine (*Pinus taeda*), tulip poplar (*Liriodendron tulipifera*), white oak (*Quercus alba*), Northern red oak (*Quercus rubra*), black cherry (*Prunus serotina*), swamp white oak (*Quercus bicolor*), American hornbeam (*Ostrya virginiana*), and American holly (*Ilex opaca*).

Recently, monitoring projects implemented by the DNERR have established at the Blackbird Creek Reserve. These monitoring projects include NERRS Emergent Vegetation Biological Monitoring, aquatic invasive species monitoring and nest box monitoring. Additional habitat enhancements added to the Blackbird Creek Reserve include a kestrel box, which will be monitored by the Brandywine Zoo's Delaware Kestrel Partnership. In 2016, Bio-Monitoring was expanded to the Blackbird Creek Reserve and is comprised of a Surface Elevation Table (SET), emergent vegetation monitoring and elevation surveys. This research is being used to establish the DNERR as a sentinel site for climate change in Delaware through monitoring of long term changes of emergent vegetation and sediment studies. In 2018, aquatic invasive species monitoring was implemented to eradicate Parrot's Feather (*Myriophyllum aquaticum*) from coastal plain ponds.

Habitat maps have been completed for the Blackbird Creek reserve, but the habitat maps were created using 2007 aerial imagery. The 2007 DNERR Habitat Maps will act as a baseline information to understand how current and future restoration efforts have changed the landscape of the Blackbird Creek Reserve (Appendix A). As future habitat maps are created, they will include additional property acquisitions and highlight the progression of areas that are actively being restored.

Table 2. Activities completed outside of the 2007 Ecological Restoration Plan

Restoration Type & Management Section #	Restoration Description	Year	Restoration Type Changed from Original Plan?
Reforestation			
Section 18	Delaware State University: Reforestation and growth monitoring (Dr. Mingxin Guo)	2011-2015	Y
Section 2	Native Tree Plot for education	2010	Y
Other: Monitoring & Design			
Section 18	University of Delaware: Headwater stream (Stephanie Stotts, Micheal O'Neal & Dan Hubacz) data collection	2012	N
Section 1	Demonstration living shoreline installed to prevent erosion near canoe & kayak launch	2015	N
Section 4	Pond: Invasive species monitoring and management	2018	N
Section 9	Tidal Marsh: Surface Elevation Table (SET), vegetation monitoring (species composition & percent cover)	2016	
Other: Acquired Property			
Jacobs Property (Portion of Section 16)	House demolition and reforestation	2011	N/A
Unruh Property (Section 14)	Invasive species control	2015	N/A
McKinley-Merritt (Sections 16 & 17)	Invasive species control	2015	N/A
Norris Property (Section 12 & half of Section 7)	Building removal, demolition and invasive species control	2016	N/A
Manwaring Property (Portion of Sections 5 & 6)	Demolition and invasive species control	2017	N/A

3.0 SUSTAINABILITY AND STEWARDSHIP

3.1 Sustainable Facilities and Infrastructure

The DNERR recognizes that new facilities need to be compatible with and support conservation and ecological efforts at the Blackbird Creek Reserve. The DNERR has followed the recommendations the *Blackbird Creek Reserve Ecological Restoration Master Plan* to avoid the placement of new facilities in sensitive areas including wetlands, streams, riparian buffers, rare species habitat areas, steep slopes or forest interior areas.

The basic principles that the DNERR has followed includes:

- Minimize the overall size/footprint and disturbance of construction
- Avoid impacts to sensitive natural resources (identified above)
- Place facilities in existing disturbed/altered areas
- Emphasize the minimization of run-off and design for infiltration

3.2 Stewardship Opportunities at the Blackbird Creek Reserve

Providing stewardship opportunities at the Blackbird Creek Reserve was identified as a need for “public use, participation and education.” The Education and Stewardship sector of the DNERR work together to provide opportunities to the public. Reforestation efforts at the Blackbird Creek Reserve have been used as public programs for volunteers, such as potting trees for the Native Plant Garden on Earth Day and planting trees within restoration plots on National Estuaries Day. Groups that have volunteered at the Blackbird Creek Reserve include Boy Scouts and Girl Scouts, local schools and individuals from neighboring communities. Fresh to brackish tidal creek and marsh systems have been highlighted by the Education sector of the DNERR through canoe and kayaking trips along the Blackbird Creek. Annually, the DNERR hosts the “Blackbird Creek Fall Festival” that promotes the use of the Blackbird Creek Reserve and educates visitors on the importance of the Delaware Bay.

As indicated in Table 3, the Blackbird Creek Reserve has trails for public use and they were expanded to include a 1 mile, 2K and 5K loop. These trails are self-guided with maps in kiosks and bird watching benches to provide areas for individuals to rest. In the past, the public would become concerned when hunting signs were placed along the trails and it would deter them from using the Blackbird Creek Reserve trails. Through discussions with the Delaware Division of Fish and Wildlife, public use trails are confined to the 803 Blackbird Landing Road property and hunting is limited to specific properties of the Blackbird Creek Reserve to eliminate conflicting uses between the public and hunters.

Table 3. Sustainable facilities and infrastructures that have been completed since 2007.

Restoration Type & Mangement Section #	Restoration Description	Year
Other: Property Appeal		
Section 9	Installed 5 Bat Boxes	2011
Section 1	Blackbird Trail system - 5K and 2K	2012
	Canoe/Kayak Launch	2012
	Education Pavilion and Rest Rooms	2016
	Parking and Turn-around/Drive	2016
Section 15	Created maintenance trail to manage invasive species	2017

4.0 ECOLOGICAL RESTORATION

4.1 Over-arching Mission and Goals

The over-arching mission and goals of the Stewardship Plan for the Blackbird Creek Reserve are influenced at several levels, including guidance from the NERRS and reserve-specific DNERR Management Plan goals. Objectives relating to the achieving the goals provided by the DNERR staff and DNREC personnel in the *Blackbird Creek Reserve Ecological Restoration Master Plan* will still remain a part of future restoration at the DNERR.

The overall NERRS mission is – *“To practice and promote stewardship of coasts and estuaries through innovative research education and training using a place-based system of protected areas.”*

The NERRS has a Restoration Science Strategy that can be summarized:

The NERRS restoration science initiative has set general *“Habitat Restoration Priorities for Each Reserve.”* The DNERR restoration priorities, as determined by the NERRS restoration science initiative, are generally defined as:

- Invasive species
- Upland habitat
- Other

The “Other” category references smaller, local habitat types of concern not representative of the national strategy.

A Restoration Science Strategy

The National Estuary Research Reserve System is developing a Habitat Restoration Strategy to provide the scientific basis and technical expertise to restore, enhance and maintain estuarine ecosystems. The plan will develop and transfer effective approaches to identify, prioritize, restore and monitor degraded or lost coastal habitat. The strategy uses a partnership approach coupled with education and community involvement. The restoration areas in which the reserve system hopes to play a national role includes:

- Project planning
- Developing effective approaches to test and evaluate innovative technology for restoration
- Monitoring restoration response
- Serving as local reference or control sites
- Translating/transferring restoration information
- Providing scientific and technological advise to support policy and regulatory decisions
- Building awareness for the value of restoration science
- Coordinating regional science

As a companion, the NERRS also identifies '*Lost, Disturbed or Damaged Habitat Within Each Reserve,*' and for the DNERR they are as follows:

- Salt/Brackish marsh
- Tidal freshwater wetlands
- Upland forest/meadow
- Riverine/riparian wetlands
- Coastal prairie/scrub

The above priorities are for both the St. Jones Reserve and Blackbird Creek Reserve of the DNERR. Specific priorities for each site are not distinguished.

The Reserve and DNREC identified objectives and implementation plan for the *Blackbird Creek Reserve Ecological Restoration Master Plan* that included:

- Define restoration targets for the plan
- Improve land use activities from a water quality perspective
- Provide holistic restoration plan for now, and set the stage for long-term monitoring
- Identify associated innovation stormwater techniques
- Produce results on the ground in the near-term
- Lead to demonstration plots for wildlife habitat types (e.g., for mammals)
- Act as a model for others in the watershed

Since the DNERR is still in the process of implementing phases from the *Blackbird Creek Reserve Ecological Restoration Master Plan*, the objectives and implementation plan have not changed.

4.2 Restoration Approach

The restoration of the Blackbird Creek Reserve parcels will continue to involve multiple techniques and restoration approaches. These techniques and approaches are dependent upon the condition of the ecological resources that are targeted for restoration and resources available to achieve the restoration goals.

The scale and focus of restoration effort is an important issue to address for any ecological restoration project or program. Ecological restoration can occur at a variety of levels including a system, community, population or species focus. At broad scales, it becomes even more difficult to decide what should be restored, where and how (Hobb, 2002). Other major considerations revolve around a landscape level ecological context and/or restoring natural functions and processes. Whatever is carried out in the way of restoration should involve working with, and not in opposition to, or simply improved management of the resource. Parker & Pickett (1997) indicate that restoration should be considered a process, with the degree of active intervention being determined by contextual circumstances.

4.3 Guiding Principles for Restoration

The following *Guiding Principles* are used to guide the conceptual ecological restoration initiatives identified in the *Blackbird Creek Reserve Ecological Restoration Master Plan* and will be used for associated restoration design and implementation/construction processes.

- Protect and maintain existing habitat patches, and restore habitat to provide larger patches and increase the connectivity of habitat corridors
- Maintain existing high quality habitat conditions and improve degraded habitat conditions by removing threats or threatening processes
- Improve the condition of relic habitats in fragmented landscapes to ensure their persistence
- Emphasizing supporting and regenerating natural processes for system recovery
- Conserve non-renewable energy in restoration approaches
- Support ecosystem conservation practices in all related activities
- Use applied monitoring and research to test ecological theories
- Consider human needs and compatibility with the needs of biotic systems

Given the degree to which specific ecological resources have been identified to be degraded or damaged, and other resources are threatened, the *Restoration Approach* for the Blackbird Component is recommended to include:

- Active restoration of specific degraded or impacted existing ecological resources including ; non-tidal wetlands, streams, and riparian buffers

- Creation of additional habitats that are fragmented, reduced or eliminated from the landscape (including: wetlands, upland reforestation, and native meadows)
- Use varying degrees of non-native invasive species management to protect existing natural communities, and as a part of restoring degraded habitat areas
- Identify compatible ideas for sustainable facilities, best management practices (e.g. stormwater), and stewardship opportunities to support restoration
- Adaptive management in the form of restoration implementation, monitoring, and informed decisions making based on the analysis of the monitoring results

5.0 RESTORATION RECCOMENDATIONS

5.1 Restoration and Priorities

The identification of restoration priorities is important for the restoration properties within the Blackbird Creek Reserve. In the truest sense of adaptive management (learning through implementation, testing, and modifying practices) the actual restoration timing, techniques and priorities will and should change over time. This is necessary to account for research and monitoring results for initial efforts, changes in the watershed, related ecosystem function modeling. Analysis and available resources (financial and material). Building in the flexibility for changes in acreages, locations and types of restoration projects and approaches is inherent in this plan.

The *Blackbird Creek Reserve Ecological Restoration Master Plan* recommended the following restoration types:

- Headwater stream restoration
- Riparian corridor buffer restoration
- Invasive species management
- Wetland restoration – freshwater nontidal
- Wetland restoration – tidal marsh
- Upland reforestation
- Upland native meadow restoration

These restoration types will remain priority for this plan as the DNERR continues to complete recommendations from the *Blackbird Creek Reserve Ecological Restoration Master Plan*. Unlike the previous plan, the DNERR Stewardship Plan will not contain Phases with specific timelines. Instead, management areas have been created for all properties actively managed at the Blackbird Creek Reserve. These management areas have been numbered to easily track all restoration activities within the Blackbird Creek Reserve (Figure 2 & 3). As previously mentioned, the intention of this Stewardship Plan is to guide restoration at the Blackbird Creek Reserve and reevaluate the success of the restoration activities in 5 years.

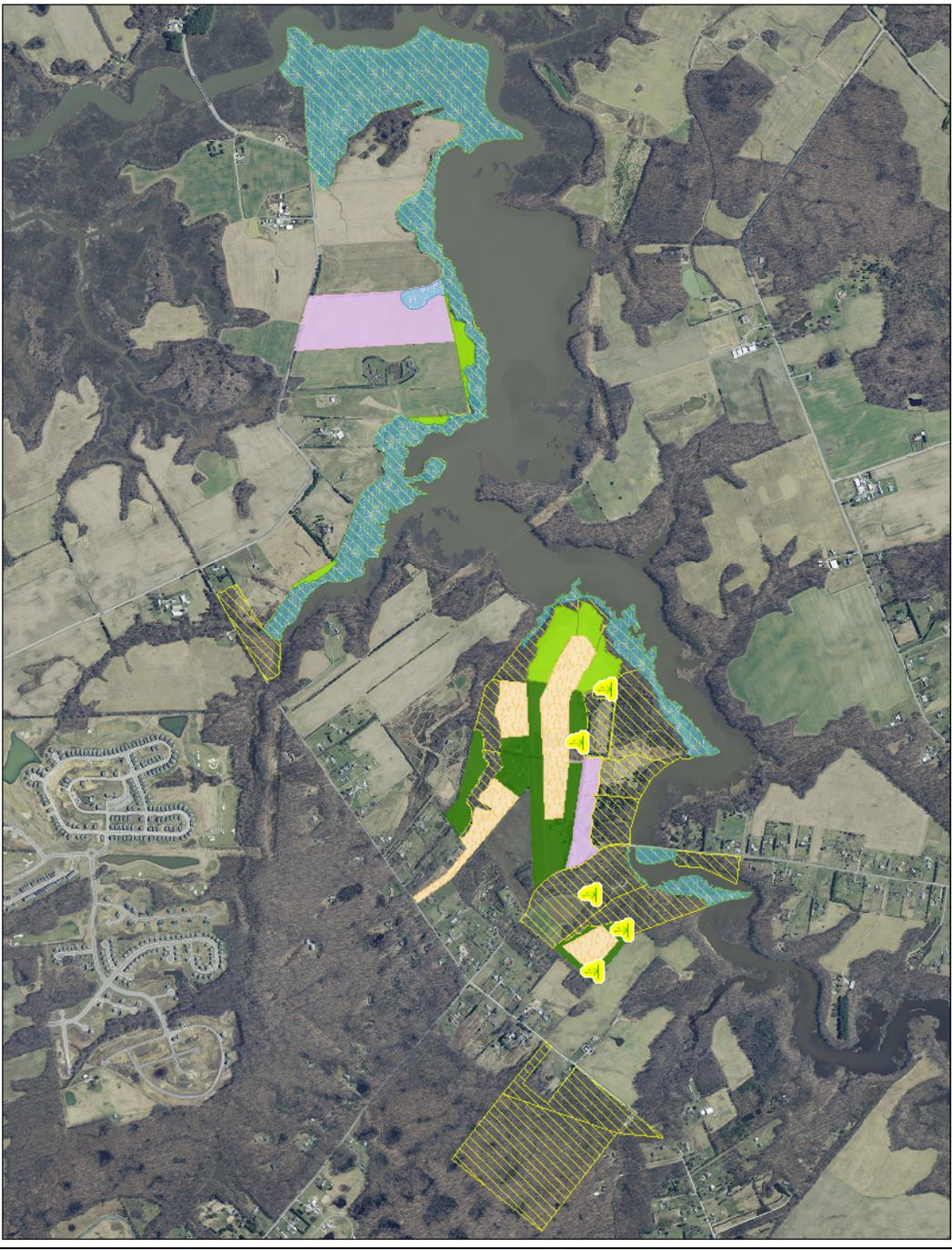
Over the past several years, the Blackbird Creek Reserve has acquired additional properties to enhance current restoration activities and protect important habitats. It has been a priority to stabilize (control invasive species) and initiate restoration (demolition of buildings) on new properties. It is recommended to continue prioritizing invasive species treatment on all new properties after any new properties have been acquired. This will prevent the spread of invasive to nearby parcels that the DNERR actively controls for invasive species. It is also recommended that any new properties acquired after the DNERR Stewardship Plan would prioritize maintenance for invasive species over restoration. A plan for restoration would be created for new properties during the next 5 year update for the DNERR Stewardship Plan, unless funding for a new property has specific restoration requirements.

A DNERR Stewardship Plan map has been updated to reflect the current restoration plan for the Blackbird Creek Reserve. This map is not intended to reflect outcomes for the next 5 years, instead it is to be used as guidance for long-term restoration planning (Figure 7). The following sub-sections of this plan describe the approach to complete the recommended ecological restoration types from the *Blackbird Creek Reserve Ecological Restoration Master Plan* and include recently acquired properties that were not in the previous restoration plan. Recommendations for monitoring and research needs, data gaps and focal animals species for each habitat type will remain the same and can be found in the *Blackbird Creek Reserve Ecological Restoration Master Plan*.



**DNERR Stewardship Plan
Blackbird Creek Reserve
Figure 4**

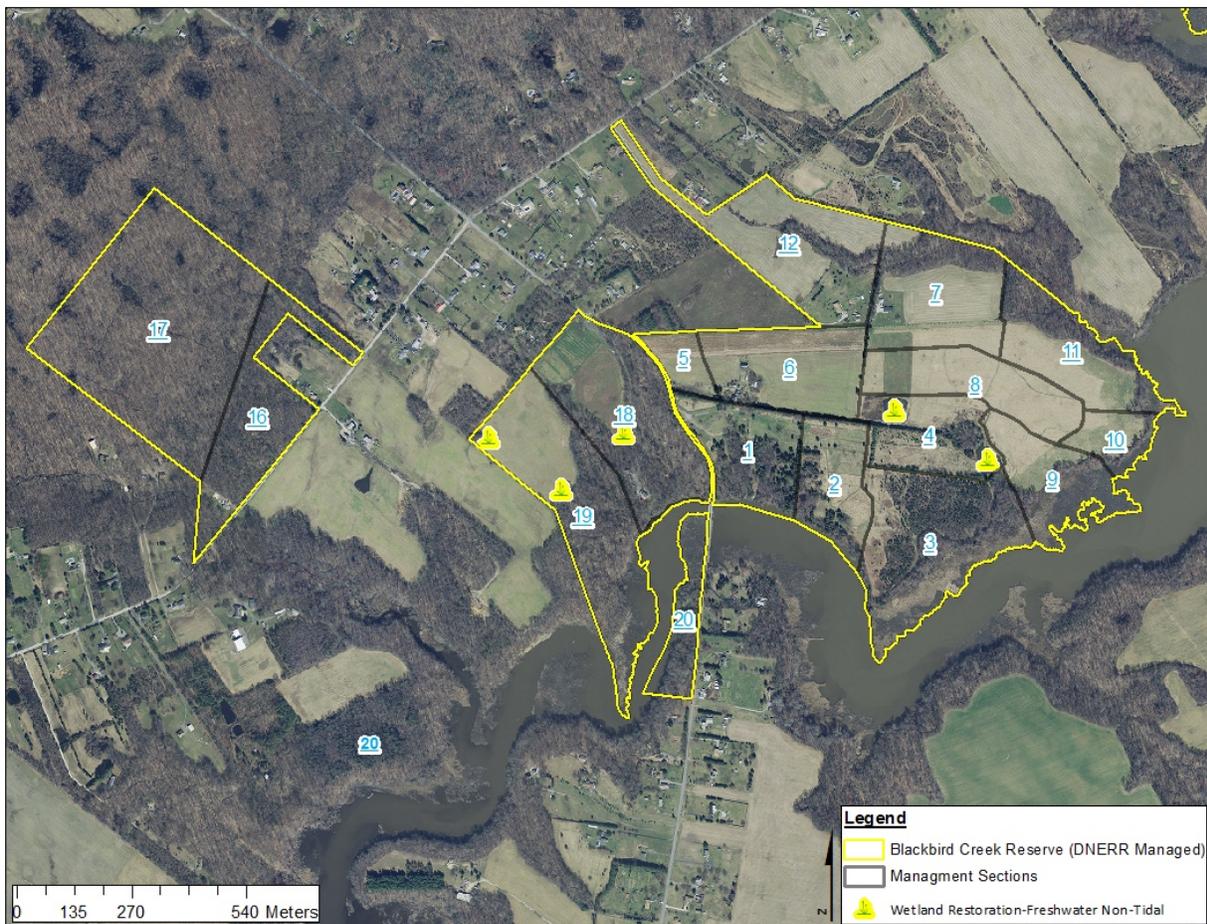
- Wetland Restoration-Freshwater Non-Tidal
- Wetland Restoration-Tidal Marsh
- Native Meadow Restoration
- Riparian Reforestation
- Upland Reforestation
- Invasive Species Management
- General Management/No specific plan



5.1.1 Wetland Restoration – Freshwater Non-Tidal

Non-tidal wetland restoration is recommended to include ‘coastal plain pond’ restoration (also potentially involving the conversion of man-made ponds), and the creation of forested or emergent headwater wetlands at headwater streams and in lowing/moist soil areas of agricultural fields and fallow fields. Disturbance to existing springheads and/or spring seeps should be avoided to prevent negative impacts (such as species elimination due to habitat disturbance) to stream salamanders. Additional restoration of existing forested non-tidal wetlands primarily involves invasive species management and supplemental native planting for reforestation.

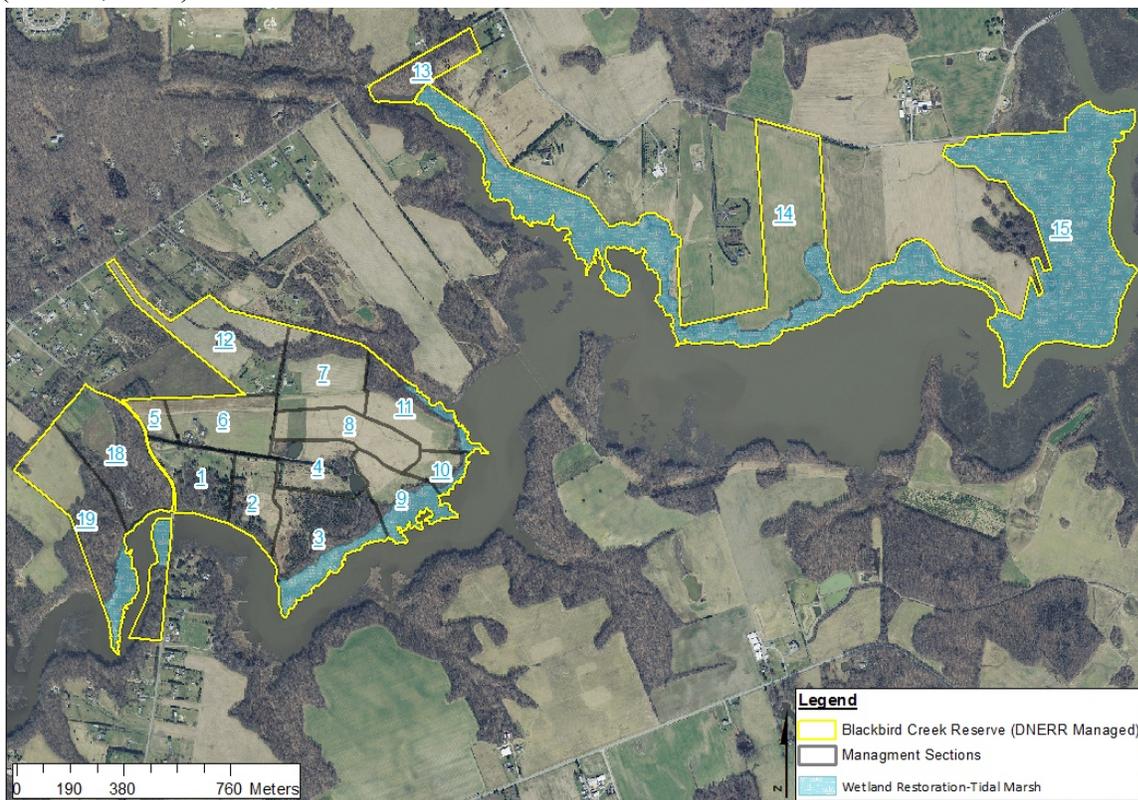
Management Areas 18 & 19 both contain ponds that have been restored with native wetland plant species. All ponds are currently being managed for invasive species with the goal to eradicate and prevent invasive from entering the Blackbird Creek. Invasive species monitoring has been implemented at a pond in Management Area 4 and will be implemented in other ponds if invasive plants are identified. Disturbance to existing coastal plain ponds identified in Management Areas 16 & 17 should be avoided and controlled for invasive species.



5.1.2 Wetland Restoration – Tidal Marsh

Tidal restoration is recommended to include oligohaline to brackish marsh restoration involving a comprehensive strategy, in concert with other types of restoration and management projects throughout the Reserve lands, to restore their native vegetation composition. Other related elements for wetland system restoration include addressing sea level rise and marsh subsidence in a localized, long term research and monitoring plan. Short-term efforts should focus on the control of non-native invasive *Phragmites*, where it is encroaching into other native species dominated marshes. Other possible tidal wetland restoration measure can include sediment dredging and raising marsh surfaces or passive material structures (logs and rock sills) and waterfowl exclusion to increase tidal marsh areas.

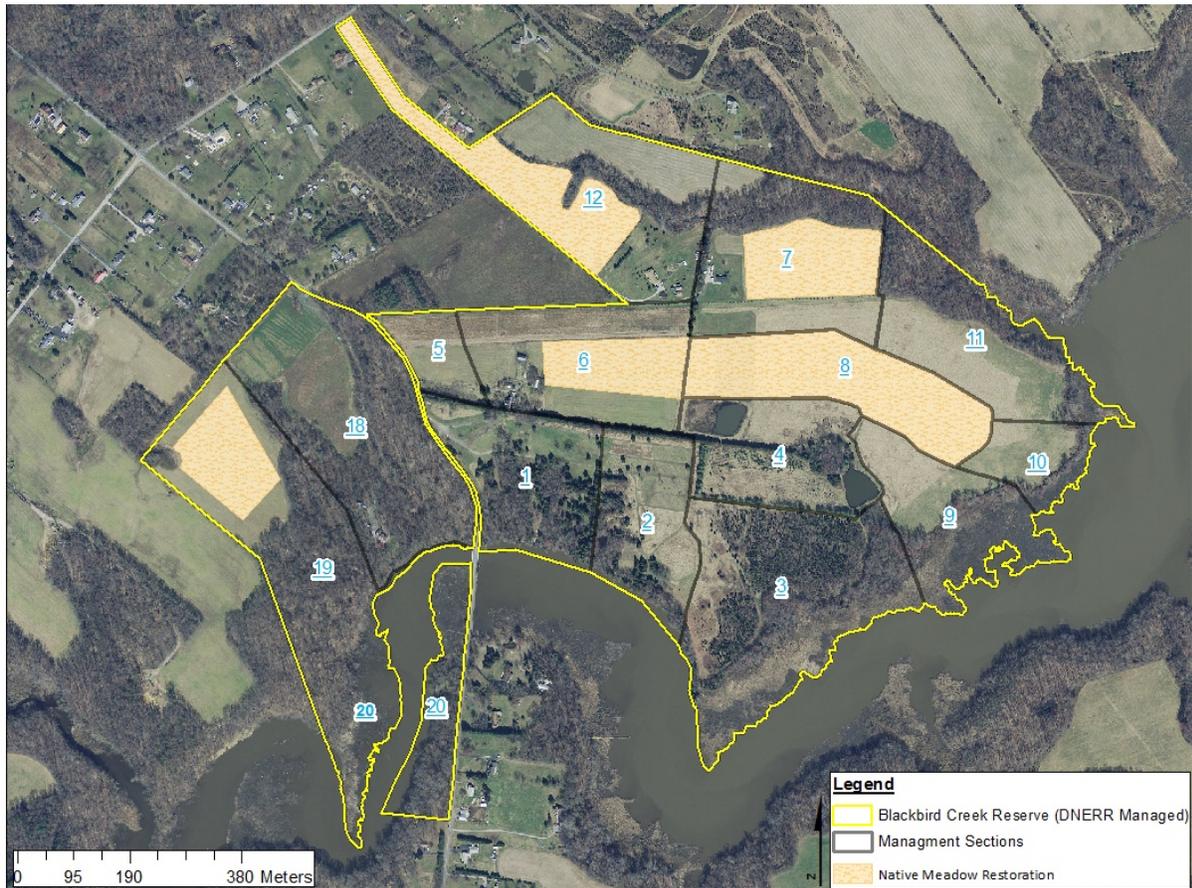
Biological vegetation monitoring has been established within the tidal wetlands of Management Area 9 to monitor long term changes and the expansion of invasive *Phragmites*. A living shoreline demonstration project has been established at the canoe/kayak launch within Management Area 2. It is recommended to continue efforts that would allow that use to living shorelines to stabilize the shoreline and native vegetation by identifying partners from local or regional organizations (e.g. DNREC, USFWS, US Army Corps of Engineers or other collaborating organizations) and following NOAA’s guidelines for the use of living shorelines (NOAA, 2015).



5.1.3 Native Meadow Restoration

Upland Native Meadow restoration is recommended for a large portion of the fallow fields of the Blackbird Creek Reserve. This habitat type will add to the diversity and mosaic of habitat types on the Blackbird Component without compromising the intended riparian buffers, wetland restoration or upland reforestation. Native meadow will provide habitat for some niche species including Lepidoptera (butterflies, moths and skippers), small mammals, non-area-sensitive grassland birds and herps. Native meadow restoration approaches will include non-persistent, targeted herbicide treatment of cool season grasses and weeds followed by drilling seeding native warm season grasses and wild flowers. Other options include allowing natural succession and monitoring weeds or plant invasion potential and treating those invasions by herbicides, strategic time of year mowing, or controlled cool season burns. To prevent mass mortality in box turtles and other herps, strategic mowing will have a mower height of no lower than 6 inches and will be avoided in May & June. Later in the summer, strategic mowing will be restricted to the hottest and driest times of the day and avoided in the morning when any fields may be shaded or when soil moisture is high after heavy rains.

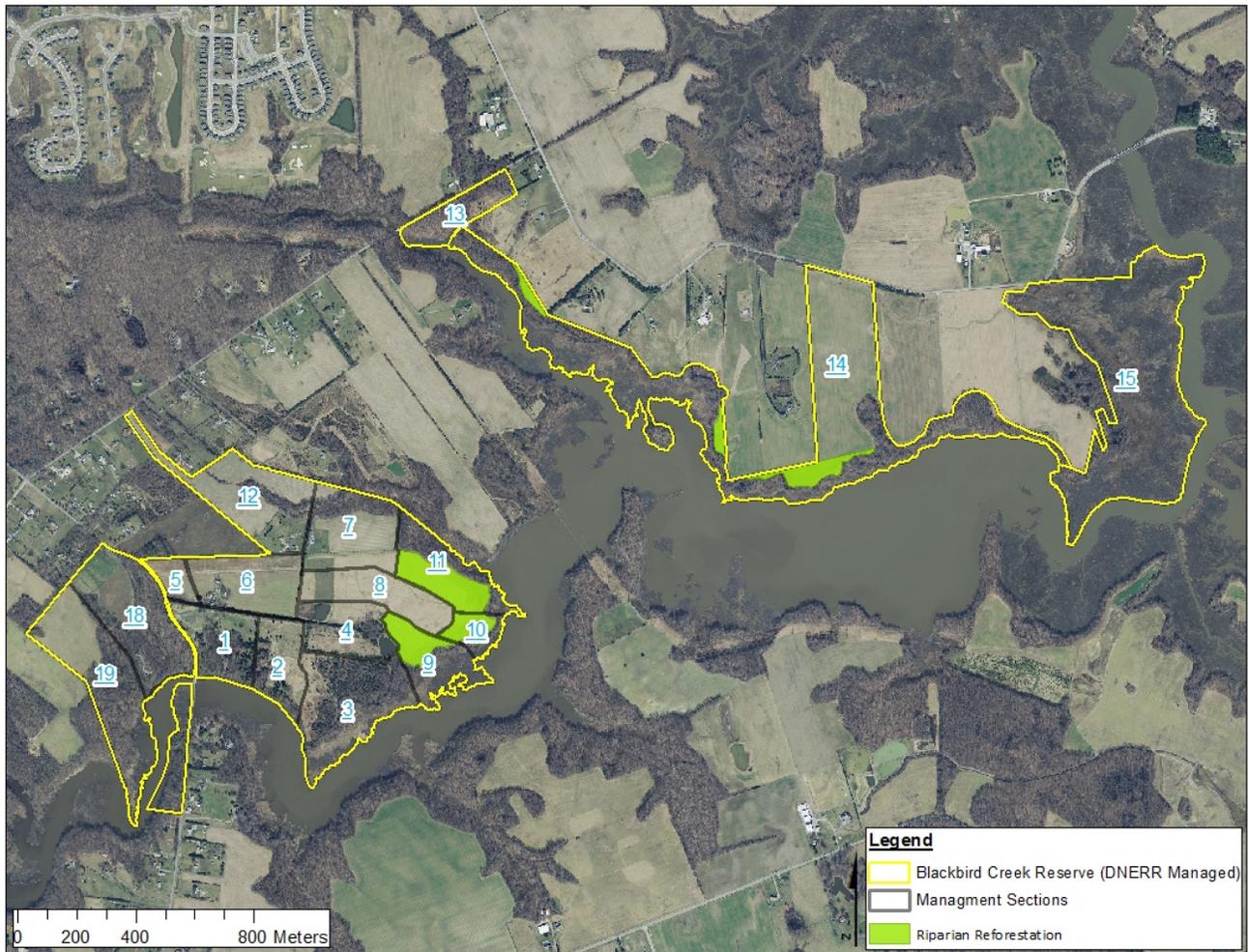
Currently, portions of Management Areas 19, 12 and 7 are used as agriculture fields. Agriculture farming will continue until decisions are made on the exact timing of each restoration effort.



5.1.4 Riparian Restoration

Riparian buffer restoration is recommended for the Blackbird Creek mainstem and all the stream tributaries on DNERR managed properties. Buffer restoration is recommended in the form of native reforestation plantings and natural succession management where the existing buffer is non-existent, inadequate in width, or poorly structured. In this ecosystem, an expanded forested buffer is generally recommended (for mesic to dry hardwood forest types) with the potential for minor inclusions of scrub-shrub or limited patches of native coastal plain meadow. Riparian restoration efforts will be integrated with invasive management measures.

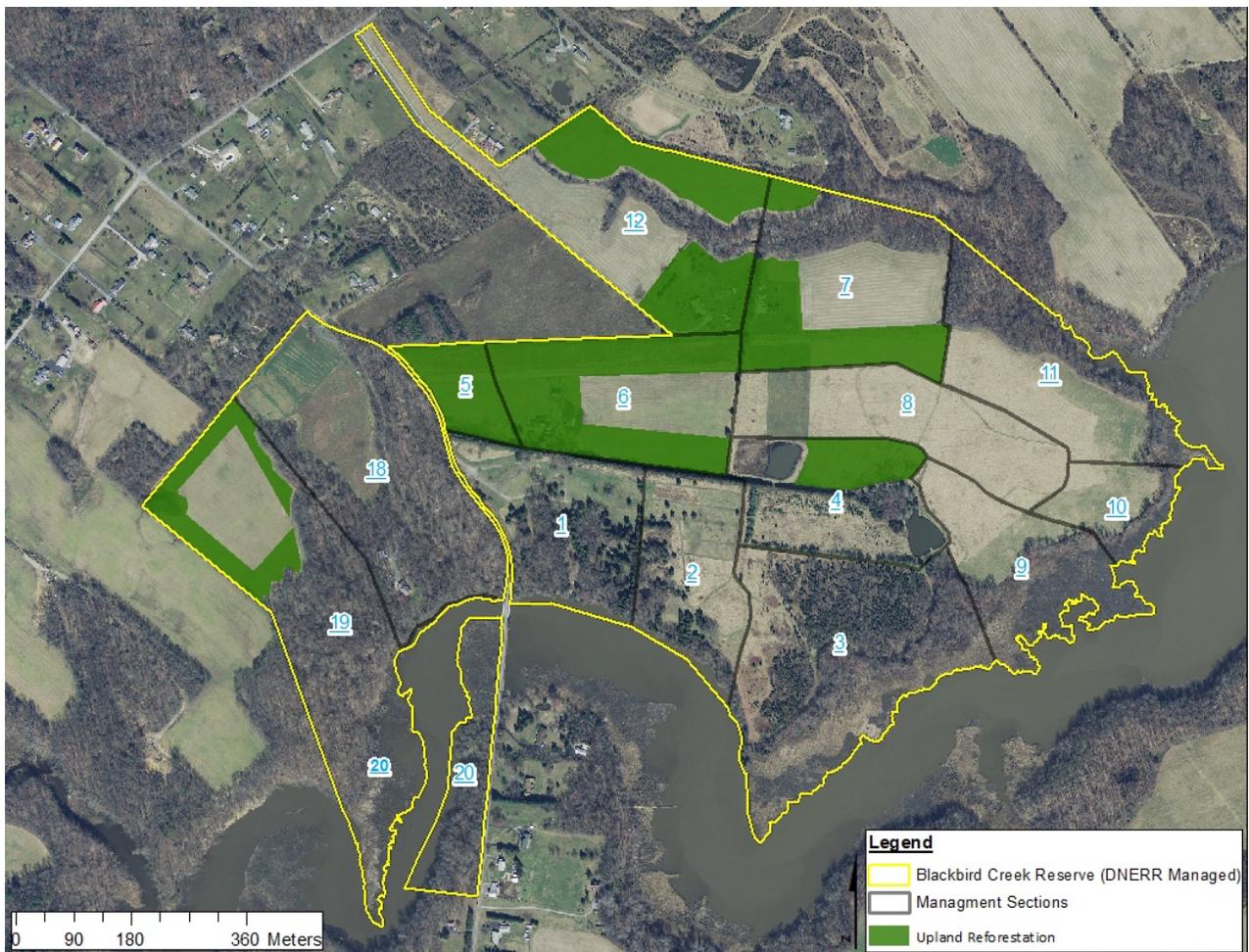
It is recommended to continue the process of mowing areas with recently planted trees to increase the survival rate. As needed, reevaluate the area and plant trees to fill areas where seasonal weather or wildlife have destroyed plantings. After the trees have become established, allow natural succession for woodland recruitment.



5.1.5 Upland Reforestation

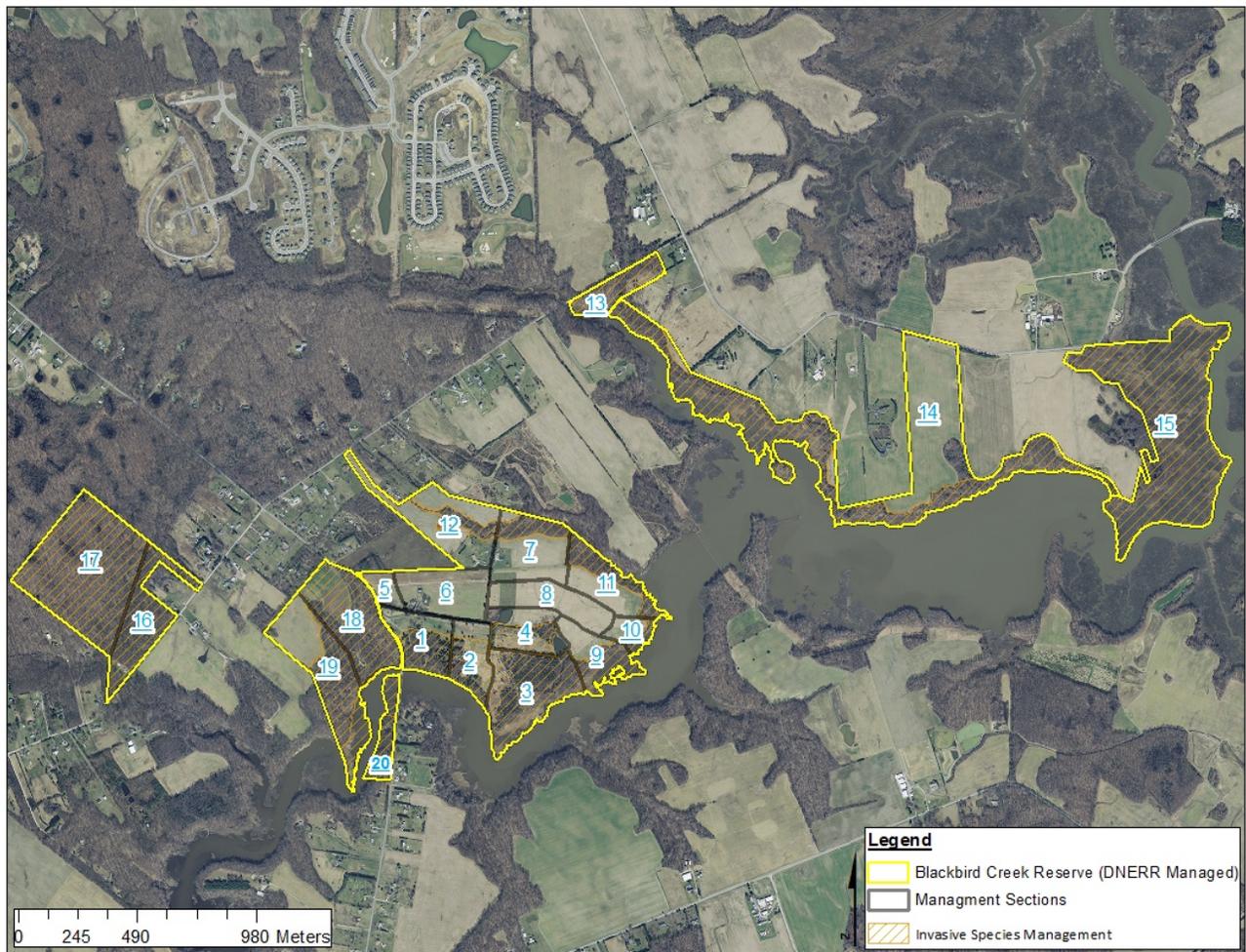
Upland reforestation is recommended in addition to the recommendations for riparian buffer restoration. Additional reforestation is recommended specifically to extend existing blocks of upland forest and to add further buffer area to anticipated wetland restoration and coastal pond creation areas. Reforestation approaches will include various techniques including natural succession management, planting various propagules (seeds, tubelings, bare root plants, container-grown nursery stock), and soil amendments. Reforestation efforts will be integrated with invasive management measures.

The goal of upland reforestation in Management Areas 5, 9, 7, and 12 is to create a wildlife corridor to minimize habitat fragmentation and provide safe passage for animals within the Blackbird Creek Reserve. Upland reforestation in Management Areas 19 and 4 will be extending currently established forest areas. When possible, it is recommended to use larger trees for upland reforestation to limit the amount of time invested in mowing around trees and speed up the reforestation process.



5.1.6 Invasive Species Management

Invasive species management is needed for all habitat types in the Blackbird Creek Reserve. Not all invasive species management efforts involve active invasive species treatment, removal and control. Invasive species management includes baseline assessment, monitoring, active control, passive control and combining invasive species management with other types of projects, such as stream restoration, wetland restoration, and reforestation. Priority non-native invasive species for control are Kudzu (*Pueraria montana*), Canada thistle (*Cirsium arvense*), multiflora rose (*Rosa multiflora*) and Parrot's-feather-water-milfoil (*Myriophyllum aquaticum*). Common reed (*Phragmites australis*) needs to be addressed in a comprehensive long term fashion, rather than attempts at short term total eradication, due to its homogenous occurrence throughout the Blackbird Creek tidal marsh system. Further study of the implications of long term agricultural land nutrient delivery to the marsh and species control techniques include stem/stump cut herbicide (non-persistent) treatments, physical manual removal, soil amendments, hydrology manipulation, controlled burning and native plantings.



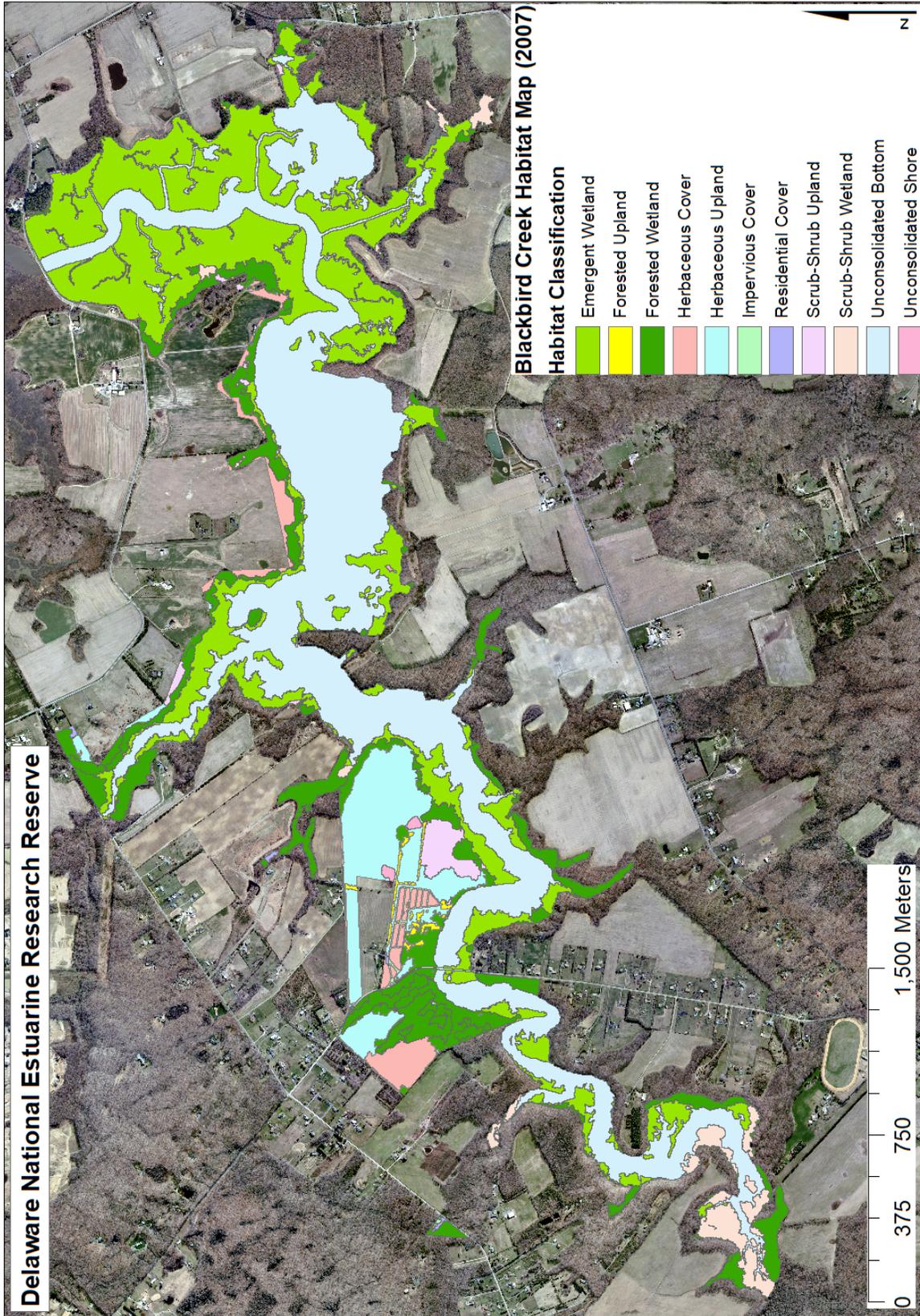
For specific ecological restoration projects and managed areas, control of all “priority” species referenced above to <5% coverage to keep these aggressive species in check. Due to requirements of Delaware’s Noxious Weed Law, Canada thistle must be completely controlled (a 0% cover target). For all other existing non-native invasive species, manage for less than 15% total coverage, reflecting a greater tolerance for their occurrence in the system. The targets for invasive species management are based on the biology and character of the species to be controlled and the practicality of achieving control.

6.0 REFERENCES

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- National Oceanic and Atmospheric Administration (NOAA). 2015 online. Guidance for Considering the Use of Living Shorelines. NOAA Restoration Center, Office of Habitat Conservation, NOAA Fisheries, Silver Spring, MD. URL: https://www.habitatblueprint.noaa.gov/wp-content/uploads/2018/01/NOAA-Guidance-for-Considering-the-Use-of-Living-Shorelines_2015.pdf
- National Oceanic and Atmospheric Administration (NOAA). The National Estuarine Research Reserve System Strategic Plan 2017-2022. NOAA Office for Coastal Management.
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- Thayer, Gordon W., T.A. McTigue, R.J. Bellmer, F.M. Burrows, S.H. Merkey, A.D. Nickens, S.J. Lozano, P.R. Gayaldo, P.J. Polmateer, and P.T. Pinit, 2003. Science-Based Restoration Monitoring of Coastal Habitats, Volume One: A Framework for Monitoring Plans Under the Estuaries and Clean Waters Act of 2000 (Public Law 160-457). NOAA Coastal Ocean Program Decision Analysis Series No. 23, Volume 1. NOAA National Centers for Coastal Ocean Sciences, Silver Spring, MD. 35pp. plus appendices.

APPENDIX A

Delaware National Estuarine Research Reserve



APPENDIX B

NOAA Restoration Monitoring Guidance

NOAA restoration monitoring guidance documents (Thayer et al 2003, Pinit et al 2000) identify 13 habitat types for coastal freshwater to marine systems, and their most recent habitat type designation for monitoring are:

- Water column
- Rock bottom
- Coral reefs
- Oyster reefs
- Soft bottom
- Kelp and other macroalgae
- Rocky shoreline
- Submerged aquatic vegetation (SAV; seagrasses)
- Marsh (marine/brackish and freshwater)
- Mangrove swamps
- Deepwater swamps
- Riverine forests

The five habitat types from the list about that generally apply to the Blackbird Creek Reserve are water column, soft bottom, soft shoreline, marsh and riverine forests. First structural and functional characteristics are identified that correspond to the restored habitat type being monitored (e.g. provides breeding grounds, or supports biomass production). Based on the identified structural and functional characteristics of the habitat, specific parameters to monitor are chosen within the general categories of Geographical (acreage of habitat type), Biological (Plants and Animals), Hydrological (Physical and Chemical) and Soil and Sediment (Physical and Chemical). Many examples of specific monitoring parameters are identified in *Appendix II: Matrices of Habitat Characteristics and Parameters* (Thayer et al, 2003).